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RESOURCES

OF THE

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WITH A SKETCH OF THE

RON BELT OF VIRGINIA,

NG FORTH SOME OF THEIR MARKETS AND MEANS OF DEVELOPMENT.

BY

M. F. MAURY, Jr.

of the Geological Society of London; Associate of the Royal School of Mines, England; Graduate of the Royal College of Chemistry, London; Civil and Mining Engineer.

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THE RESOURCES OF THE COAL FIELD OF THE UPPER KANAWHA,

WITH A SKETCH OF THE

IRON BELT OF VIRGINIA,

SETTING FORTH SOME OF THEIR MARKETS AND MEANS OF DEVELOPMENT.

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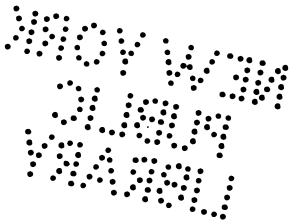

GEOLOGY.

THE rocks of the Kanawha Coal Field consist entirely of the coal measures, containing all the varieties of coal (save anthracite) known, ofttimes equalling, and sometimes excelling, the most celebrated coals of other noted coal fields.

It is characterized by geological features of great simplicity. "The surface of the region is undulating. The loftiest hills rise in gently swelling outlines, no very prominent peaks towering, acute and ragged, to denote that the strata have been subjected to violent convulsive and upheaving forces. Everything bespeaks it to have been at one time an expanded plain, gently tilted from its horizontal position, so that its surface, and the beds of rocks beneath, decline with a very slight but uniform depression towards the northwest, to the valley of the Ohio.

"Its topographical features give evidence that its inequalities were caused by the furrowing action of a mighty and devastating rush of waters, which by rapid drainage scooped out numerous valleys and basins in the upper strata. It is from this deep excavation by natural causes, combined with the other important circumstance of a nearly horizontal position, that we are to draw our estimate of the prodigious resources of a mineral kind possessed by the region before us; for, whatever valuable material be inclosed in the strata, the horizontal position alluded to, keeps them near the surface, or at an accessible depth, over enormously wide spaces of country; while the trough-like structure of the valleys, and their great depth, exposes many of these deposits to the day under positions in which mining is the

easiest imaginable, and with an extent of development not less accommodating to the researches of the geologist than to the wants of the community."*

In his Annual Report on the Geology of Virginia for 1839, Professor Rogers divides the Kanawha coal measures into an Upper and Lower Series, the line between which is a very marked stratum of black, or bluish black, flinty rock, known as the "Black Flint Ledge," which accompanies all the subjacent strata in their various undulations, and is one of the great geological landmarks of the country.

Though both are rich in coal, the Lower Series, of which I propose treating, is by far the most so. As near as can be ascertained without actual measurement, its thickness is 950 feet. Near the Hawk's Nest, on New River, it forms the upper part of Gauley Mountains, the Black Flint Ledge being at their summits. Thence dipping to the northwest at an average rate of 100 feet† to the mile, it comes down to the level of the Kanawha, its lowest member resting upon the ledge of rocks which form the Falls of that stream. Thirty-nine (39) miles from here, following the water course, or about thirty (30) in a straight line, it sinks from view a mile below Charleston, at the Elk River Shoals.

In a formation only 950 feet thick, so great a prolongation of exposures, displaying the same division of the coal series throughout, could not have existed but for the fortunate occurrence of two broad undulations or axes, retaining the strata above the level of the river, when, by a continuation of the original northwest dip, they would have been carried entirely out of view within one-third of that distance.

These were first noticed and spoken of by Professor Rogers; being located as follows: "The first, or most easterly of these undulations, is seen to commence in the neighborhood of Hughes' Creek, the strata changing from their northwest

*Geological Reconnoisance of Virginia (1836), by Professor William B. Rogers, State Geologist.

†Along the Kanawha it varies from 20 to 100 feet.

dip to the horizontal, and then rising as they extend west so as to present a southeast dip, which continues to the hill between Kelley's and Witcher's Creeks, where it is succeeded by a gentle inclination northwest, which in a short distance is followed by a restoration of the southeast dip. This latter continues to the Burning Spring, gradually elevating the strata so as to carry up the lower coal seams to some height in the hills, after which the counter dip to the northwest reappears and continues down the river to within two miles of the Ohio.''*

A resume' of what I have said is that: The Lower Series of the Kanawha Coal Measures, 950 feet thick, are formed within a belt about 36 or 37 miles wide, dip to the northwest at an angle of from 20 to 100 feet per mile, are kept above water level for this distance by two anticlinal curves, and stretch across the country in a northeast and southwest direction.

In 1853, Professor Ansted, President of the Geological Society of London, made an examination of this coal basin. As so eminent an authority cannot but carry great weight in this connection, I deem it well to quote from his report, calling attention to the correspondence between his remarks and those of Professor Rogers.

"The rocks on each side of the Kanawha and its tributaries consist exclusively of the coal measures, which lie nearly horizontal, having a general dip towards the northwest of about 20 feet to the mile. * * * * Throughout the district there are no marks whatever of other disturbances than would result from the elevation of deposits, already split asunder by crevices produced by contraction during the first consolidation of the mass from the state of mud and soft sand. I nowhere saw, in any part of the coal field, the smallest indication of faulted ground, or a single slip or

*Annual Report of the Geological Survey of Virginia for 1839, by Professor W. B. Rogers, State Geologist.

trouble that could interfere with coal working.* * * There is in all a total thickness of upwards of 63 feet of workable coal in 14 seams† actually proven on the hillside, and above water level in some of the valleys. * * The seams are of variable thickness, occasionally affected by intervening masses of shale and grit, and it will be safe to estimate the total thickness at not less than 50 feet.‡ * * It will be observed that in speaking of coal, no notice has been taken of the depth at which other beds may be looked for below the water level. The fact is, that the large number of workable seams directly available above it renders it unnecessary to sink shafts at all; and a very long time must elapse before the cost of winning coals from dry levels will be so far raised, as to justify any other style of working. It is not necessary to remark here on the unusual facilities that will attend mining operations in this district, compared with similar work in most countries, or to dwell upon its peculiar advantages. The latter are chiefly in consequence of the vicinity of navigable streams and the existence of a large number of workable seams. The former arise from the absence of faults, the horizontality of the beds, the freedom of the coal from any troublesome liberation of dangerous gases, and the certainty that there can be no incidental expenses from incursions of water."‖

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*A more extended and intimate personal knowledge with this region, enables me to confirm this most fully.

†Professor Ansted evidently means that this is the aggregate thickness of the seams when they are measured from the floor to the roof, taking no account of the various partings that may be therein; otherwise, I am unable to explain what follows in his next few lines.

‡This estimate would give (taking the sp. gr. of coal at 1.3) 80,000 tons per acre, from which, if *one-fourth* is deducted for waste, &c., there would still be 60,000 tons per acre left; which, at 11 cents per bushel, $3 per long ton of 28 bushels, (selling price at present in Charleston,) would be $180,000 as the value of the obtainable coal in one acre of ground!

‖A chapter on the Kanawha coal field from Scenery, Science and Art; or, The Note Book of a Geologist. 1854. Page 266. By Prof. D. T. Ansted, M. A.; F. G. S.; &c., &c.

It will be noticed that Professor Ansted speaks of seams below the water level. The Kanawha Coal Measures are underlaid by another coal formation, which I call the "New River Coal-field." It is over 1,000 feet thick, is not so rich in coal as the one above it, containing, so far as I am aware, only the soft bituminous coal. On New River, about twenty miles above its junction with Gauley, I have visited and examined three separate seams, and was informed of another below any that I saw, though still above water level, and, I think, another will be found above. The land on which they are, lies on the south side of New River near Dimmock Station on the Chesapeake and Ohio Railroad. My measurements were 5 feet 6 inches, 4 feet 6 inches, and 4 feet. This last showed simply in a slip on the mountain, but the person who owns it tells me that a year or so ago he cut down through the whole thickness, finding it to be 7 feet 1 inch, with 3 partings, which left 6 feet of clear coal. The other seams were all clear coal of a very soft but extremely rich and pure variety, and would have to be coked in every case for use in blast furnaces, as they are too tender to bear the weight of a charge.

The upper member of this series disappears below water level a very short distance below the Kanawha Falls, and is seen no more above the level of the river, and its coals will have to be gotten at by shafting.

Seeing that geology has made wonderful strides in the last twenty years, there may be in the minds of some a hesitancy in accepting, to the full extent, reports made in 1839 and 1853, even though by such high authorities as I have been quoting. But they are most amply confirmed by a report made by the Engineer Department of the United States to the Secretary of War, 8th February, 1871. I quote from page 49, Ex. Doc, No. 110, 3d Session 41st Congress.

"It is well known to geological men that the veins of bituminous coal which pervade the entire western slope of the Appalachian chain of mountains, have their maximum

aggregate thickness in the Kanawha Valley. From a late authentic work on the subject of Kanawha coals the following extract is made:

"'The coal fields of the Kanawha region are superior to those of Great Britain or Pennsylvania. They are regarded by eminent gentlemen as *the finest deposit of coal in the world.* The quality of Kanawha cannel is equal to the best English; its bituminous is equal to the best found in Pennsylvania, and Kanawha splint, for smelting iron, is unsurpassed. The veins lie nearly horizontal, and vary from 3 feet to 15 feet in thickness, and the aggregate thickness of the various seams in some localities amounts to 40 and 50 feet of solid coal.'"

Though the whole of the Kanawha Valley is remarkable for its coal deposits, there is one belt exceptionally so, seeming to constitute the heart of the coal field. Its limits have not yet been *clearly* defined, but it is *about* twenty miles wide, and Coalburg and Paint Creek lie on either side of its central line. Beginning in Clay County, it runs in a southwest direction, including portions of Nicholas, Fayette, Kanawha, Boone, Logan, &c., &c., counties. Within its limits, with the exception of the two mines now in operation on Campbell's Creek, and those which were on Falling Rock and Mill Creeks, are to be found all the mines, so far as I am aware, that are, or have been, worked on any considerable scale in the Lower Series of these measures. It is in *it* that lie the valuable Cannelton Coal Mines, the Old Dominion Mines, those up Paint Creek and at Coalburg, the Sebastopol seam, the Winifrede Coal Company's Mines, those at Peytona on Coal River, &c., &c.

It is generally believed in the Valley that as we recede from the Kanawha towards the heads of the many creeks which flow into it from each side, the seams become thicker. I have personally noticed this up Paint and Campbell's Creeks, and on Gauley River, 8 or 9 miles from its mouth. But more openings and extended observations will have to be made to enable

me to say positively whether this, as a general thing, is so, or whether the increase may not be confined to individual localities; though at the same time I should state that I am of opinion that the former will be found to be the case. It is to elucidate such points as these that a new geological survey of the State would be of such benefit.

Having thus shown the existence of the coal, let me now call attention to the varieties, and their quality.

Bituminous Coal.

Of this variety are many distinct strata, varying in thickness from a few inches to 7 or 8 feet, and some of it will be found in nearly every seam of the other kinds of coal.

Owing to the existence of the more important and valuable splint and cannel coals in the field, comparatively little notice has been taken of this, and consequently not much is known of it beyond the fact of its existence in large quantities.

In 1871 Pennsylvania raised 26,131,707 tons of coal, of which amount 8,446,206 tons came under the category of bituminous. In the same year the total product of the United States was 34,367,706 tons. After subtracting the production of Pennsylvania, we get 8,235,999 tons as the total production of all the remaining States in the Republic.* In other words, the amount of bituminous coal raised in Pennsylvania in 1871 was greater than the total product of all the rest of the United States.

This is the amount of good, bad and indifferent that was sent to market from the mines of that State. It is established on the authority of the report made by the Engineer Department to the Secretary of War of the United States, that "the bituminous coals of the Great Kanawha Coal Field are equal to the best bituminous found in Pennsylvania."

*Compiled from the Miner's Journal Coal Statistical Register for 1872. Pages 61 and 62.

(Vide page 8.) There is every reason, therefore, that this coal field, now that it has communication by the Chesapeake and Ohio Railroad with market, should run Pennsylvania a hard race in the production of this class of fossil fuel.

The 4 foot 6 inch to 5 foot 2 inch seam which was worked* at the mines of the Winifrede Company on Field's Creek, is bituminous with 1 foot 6 inches of splint in the bottom.† Therefore, taking it altogether, it would rather come under the head of a splinty-bituminous seam, than a simple bituminous. The following analyses were made by Professor Locke, of Cincinnati.

Composition.	Youghiogheny.	Pomeroy.	Winifrede.
Water	1.77	3.49	1.24
Volatile Matter	28.10	35.80	27.01
Ash	3.44	12.99	3.22
Fixed Carbon	66.69	47.72	68.53

These show that it is equal to the Youghiogheny and superior to the Pomeroy, and this latter is much more strikingly shown by the following: In 1853 the West Columbia Mines worked the Pomeroy seam, 3½ miles below Pomeroy, on the Ohio River. Located within a few rods of this Company's main entries was a foundry, which ordered its coal for foundry purposes from the Winifrede Mines.‡

Splint Coal

is abundant, and *per se*, or in admixture with a small quantity of bituminous, is the most valuable coal present, the seams ranging as high as 12 feet thick (as at Sebastopol on Paint Creek). It is of superior quality, its value being due to its firmness and solidity, which enables it to be handled, shifted and stored with very little loss; it burns well, leaving but little ash; has both high calorific power and inten-

*These mines, so far as I am aware, have not been worked since the war.
†Annual Report of the Superintendent to the Stockholders for 1853.
‡Report of the Superintendent for 1853.

sity; is usually remarkably free from sulphur (iron pyrites) and other impurities; has little or no tendency to clinker; is free from the danger of firing by spontaneous combustion —a great desideratum in storage and ocean transportation; is first-rate as a steam and household fire, and it has a particular adaptability in the raw state to the manufacture of iron in the blast furnace, for which purpose it is eagerly sought in districts accessible to market, as it makes a quality of iron which can only be surpassed by the use of charcoal.

In this connection the following letter is important, as it gives the views of an experienced iron master on the subject.

OFFICE OF C. & C. MENDENHALL & Co.
27 VINE ST., CINCINNATI, O.
10th October, 1867.

J. G. Paxton, Esq., Lexington, Va.

DEAR SIR:—Your note making inquiry respecting the character of Kanawha coal as a blast furnace fuel, is received.

In reply, may briefly say that we have thoroughly tested its quality for this purpose in our own furnace near Wheeling with the most satisfactory results; regarding it as better adapted to smelting iron than any known coal of the Alleghany coal field. We used the Campbell's Creek and Coalburg coals with about equal results. The estimate in which our furnace manager holds these, is evidenced from the fact that I am authorized to contract for a supply to be carried up the Ohio River to Wheeling, for use in our furnace there.*

An extensive acquaintance with nearly all parts of our Alleghany coal field, justifies me in saying that I know of no coal equal to it in every respect, and there is no portion of the field so richly developed as on the waters of the Great Kanawha, or where it can be brought into use at so cheap a rate.

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*These coals have been but little, if any, used there for several years, owing to the irregularities of river navigation, which prevented Coalburg, &c., from letting them have a constant, steady supply. For this reason I know not whether Mr. M. actually *did* make the contract he speaks of, but he has not altered his opinion of the coal.

The coal in the Mahoning Valley, Ohio, which is now used by the works of Governor Todd and others there, has hitherto been regarded as of the finest quality known by the works which use it; but our founder, who has managed furnaces for many years in that Valley, places the Kanawha coal unquestionably before it.

* * * * * * * * * * * *

Yours truly,

CYRUS MENDENHALL.

As before remarked, splint coal, as a rule, has but a small proportion of ash. This fact has a twofold importance.

1st. The smaller the quantity of ash, the less limestone is required in the furnace to flux it; less slag is formed from that particular source, and consequently less heat and less coal are needed in forming that chemical compound in the blast furnace.

2d. It is well known that phosphorus makes iron "cold short," *i. e.*, brittle under a blow; imparts fluidity to cast iron, but spoiling it for the manufacture of steel.

Professor Wormley, Chemist on the Geological Survey of Ohio, in his analysis of the ashes of coal, finds phosphorus present in every case, though, of course, in variable quantities.* The same was found to be the case in the analysis made of two noted coals for Professor J. S. Newberry, State Geologist of Ohio.

Phosphorus no doubt, therefore, occurs in those from Kanawha; but as in all cases it forms but a small percentage of the ash, and as in the Kanawha splints the ash forms such a small percentage of the coal itself, *therefore* the phosphorus will form but a small percentage of the coal itself.

It is due to this fact, amongst others, that splint coal, wherever found, owes its superiority in the blast furnace; and also, I have no doubt, that it is said, that iron smelted by it is especially adapted to the manufacture of steel by the Bessemer process, which process is superseding all others.

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* Geological Survey of Ohio. 1870. Page 428.

In Ohio this same family of coal, which there bears the name of "block," is "well adapted, in the raw state, to the smelting of iron ores. It is indeed a typical furnace coal, and forms the fuel by which fully half of the iron in the State is manufactured.* * * * It is the only fuel used in the furnaces of the extensive iron district of Cleveland, and is in fact the basis of the great iron industry of northern Ohio."†

Again, I could point out how the discovery, in Indiana, of coals (not anthracite) which can be used crude in the manufacture of iron, has within the last seven years caused the erection of furnaces and the opening of mines; how the demand for this Indiana coal far outstripped the mining development in 1871; and how, by its use in the blast furnaces of that State, iron made by it from Iron Mountain and Lake Superior ores commands from $2 to $3 more per ton at the furnace, than the same grade of pig metal made in Kentucky and Ohio will command in Indianapolis.

The following table shows the analysis of various Kanawha splint coals. For the purpose of comparison, I have added the block coal of Indiana, and the Mahoning Valley, Ohio, the Pittsburg coal and two of the best iron-making coals of Great Britain.

Locality.	Volatile Matter.	Fixed Carbon.	Ash.	Water.	Chemist.
Campbell's Creek	35.64	61.07	1.21	1.88	Riverside Iron Co., Wheeling.
Coalburg, 4 ft. seam	33.26	62.61	1.81	2.14	" " " "
Coalburg, main seam	40.50	56.50	1.50	2.00	Levette, Indiana.
Paint Creek Mines	30.13	63.74	6.13	.....	Doremus, New York.
Kelley's Creek	37.08	60.92	2.00	.....	Rogers, Virginia.
Briar Hill, Ohio	32.58	62.66	1.16	3.60	Wormley, Ohio.
Star Mine, Indiana	32.50	61.50	2.50	3.50	Levette, Indiana.
Pittsburg Coal	41.10	56.90	1.00	1.00	" "
Clyde Splint	36.80	59.00	4.20	.....	Mushet.
Worsborough, Yorkshire	48.18	60.32	1.50	.....	"

*In 1870 Ohio produced 309,033 tons of iron. Vide Report of the Secretary of State to the Governor of Ohio. 1871. Page 63.

†Geology of Ohio. 1870. Pp. 26 and 27. J. S. Newberry, State Geologist.

In conjunction with this table, I would submit an extract as to what analysis gives as a good furnace coal.

"It would appear that a furnace coal to have sufficient reducing power, should have from 58 to 62 per cent. of fixed carbon, with little hygrometric moisture and few impurities. There should be also such a physical structure as to prevent the bitumen from running together in the process of combustion and cementing the mass, and at the same time sufficient firmness to bear up under the burden of the furnace charge. 'The effects produced by such a coal,' says Mushet, 'in a blast furnace, either as to quality or quantity of cast-iron, far exceed anything in the history of the manufacture of that metal with charcoal.' With these coals a greater quantity of iron, in proportion to the fixed carbon, is produced than with anthracite; the quality of iron is better, and the wear upon the furnace is less destructive."*

Now note the reputation of some of the coals given in the table: The Briar Hill coal has been spoken of on page 13. The praise bestowed upon it is very high, indeed, but in a letter before quoted, Mr. Mendenhall says: "The coal in the Mahoning Valley† which is now used in the works of Governor Todd and others there, has hitherto been regarded as of the finest quality known by the works which use it, but our founder, who has managed furnaces for many years in the Valley, places the Kanawha coal unquestionably before it."

The coal from the Star Mine is that used for making iron at the Planet Furnace, Clay County, Indiana, and "for manufacturing iron it is not surpassed by any in the country."‡

The Pittsburg specimen is a caking coal. The analysis was made of a picked sample obtained from one of the In-

*Report on the iron smelting coals of Southern Indiana. 1871. Page 14. Prof. J. W. Foster, LL. D.

†Briar Hill is in this Valley.

‡Geology of Indiana. 1869. Page 49. Prof. E. T. Cox, State Geologist.

dianapolis coal dealers by Professor Levette, Chemist to the State Geological Survey of Indiana.

Thus we have the testimony of analyses that the Kanawha Splint ranks with the most celebrated iron coals of Ohio, Indiana and Pennsylvania, and with two of the best British iron-making ones, whilst practical tests in the furnaces of one of the large Western iron firms gives forth the verdict that in their opinion "it is better adapted to smelting iron than any known coal of the Alleghany coal field." The President of the Kanawha and Ohio Coal Company (Coalburg) has also letters from furnaces in Newport, Ky.,* and Ironton, Ohio, speaking of it in the highest terms, for at both of these places it has been used.

Its firmness and capability of bearing handling and transportation has been remarked on; but this will be better appreciated when it is stated, that where it has been thrown out on the mountain side many years ago, from old openings, it may be found in many cases covered with moss, while on the shoals of the creeks and rivers are scattered lumps, varying from the size of a pebble up to 20 and 30 pounds weight, smooth and water-worn. How long they have been there no man can tell, and yet break them in either case and they are as black, rich, pure, sound and solid as when first severed from the mother seam.

Cannel Coal.

These seams vary from 5 feet down, and exposures are found in very many places throughout the coal field. It is universally associated with some other kind of coal, usually bituminous; a very fortunate circumstance, as the "bearing in" can be done in this latter, leaving the whole of the cannel available; and as it separates very easily from the

*The Kenton Furnace at this place has used some 10,000 tons of the Campbell's Creek Coal, mixing it with an equal amount of Connellsville Coke. Of this mixture it took 1¾ tons to make 1 ton of iron.

others, a ten or twelve inch stratum in a large seam can be gotten out profitably and shipped by itself. Were it otherwise, it would have to be mined with the rest and sold at the smaller prices of lower grades.

Unfortunately from the peculiarity of its geological deposition, it cannot be stated over what area any given seam of it will be found, or how long it will last of any given thickness, so that it cannot be reasoned that, because a 5 foot seam is found on the northern edge of, say 5,000 acres, it will be found on the southern edge. The *seam* will be found, but the cannel may have been completely displaced by another kind of coal.

This will be made more clear by a few examples:

The celebrated Boghead cannel, of Scotland, varies from 1 inch to 2 feet 6 inches.* The cannel in the seam at Cannelton, on the Kanawha, has extremes in the workings of 10 inches and 5 feet.† A half a mile to the east or west the seam is found of full thickness; in one case all bituminous, in the other all splint, but no cannel in either; while directly across the river, so far as I am aware, it is still absent. At Peytona, on Coal River, the thinnest place yet found in the seam now worked is 2 feet 6 inches, and the thickest 3 feet 8 inches. The entry is about half a mile from the river, but cross the stream, and the cannel has disappeared.

Another example: Some four miles up Paint Creek, before the war, two companies made oil from this mineral. On the east side of the creek a seam was opened and worked till the cannel stratum became too thin to get out easily. An opening was then made on the west side, about 800 yards from the first, and the cannel was found 40 inches. A mile further to the west I have opened this same seam to its usual thickness, but the cannel had dwindled down to

* Mineral Statistics of Great Britain for 1865. Page 222. By Robert Hunt, Keeper of the Mining Records.

† The average is from 39 to 42 inches.

14 inches. From its frequency in this Valley there is no telling where it may not be found, but only an actual opening on it can prove its existence, and in searching for it, and in determining the extent of a deposit, the annular diamond drills can be most advantageously used.

The chief value of this coal is as a household fuel and a gas producer. As the latter it has no superior, and that from this coal field, so far as it has been tested, occupies the highest position of any known, save only that from Boghead, Scotland.

The following table shows these qualities as compared with Boghead and the Penn Gas Coal, which latter has been very generally adopted in this country as a standard. I have also put in a specimen of the Ohio cannel, the analysis of which was the richest in a table which will be found on page 420 of the State Geological Survey of Ohio for 1870, of ten others from the same State.

Localities.	Fixed Carbon.	Volatile Matter.	Lbs. of Sulphur in 2240 Lbs.	Ash.	Cub. Ft. of Gas per Ton.	Value of One Ton in Lbs. of Spermaceti.	Chemist.
Cannelton, (average)...	41.30	46.50	7.96	12.20	11648	950.6	Chas. M. Cresson.
Cannelton, (selected)...	43.20	46.50	7.96	10.20	12588	992.7	" " "
Peytona.....	41.00	46.00	.....	13.00	13200	.....	Manhattan Gas Light Co., N. Y.
Boghead.....	9.25	69.00	3.10	21.75	15426	2755.6	Dr. Fyfe.
Penn. Gas Coal.....	61.00	35.80	9.77	3.20	9856	473.	Chas M. Cresson.
Canton, Ohio.....	59.50	34.50	.....	6.00	8534	.....	Wormley, Ohio.

"The Boghead coal occurs in the higher part of the Scotch coal field, and its range does not extend more than 3 or 4 miles. * * * * In thickness it varies from 1 to 30 inches, and at the present rate of consumption, say from 8,000 to 10,000 tons per annum, it cannot last many years."*

According to this, therefore, the days of that coal are being numbered, and when mined no longer it bequeaths to the Kanawha cannel the rich legacy of being unequalled in its gas-producing qualities by any coal known.

* Mineral Statistics of Great Britain. 1865. Page 222.

Another source of revenue from this is its yield of oil, which should generally be about 60 gallons per ton. Peytona cannel gives:

Crude illuminating oil	20 gals.
Crude lubricating oil	52 "
Oily parafin	7.2 "
	79.2 "*

Cannelton cannel yielded 2 gallons per bushel, or 56 gallons per ton. This is really not the full yield, as when the retorts were taken up, the present company found there had been considerable waste and leakage. It is now shipped altogether in bulk from this place. As before mentioned, two companies distilled oil from this mineral on Paint Creek. They were stopped chiefly on account of the war, and have not resumed operations since, partly from lack of capital and partly from the discoveries of the cheaper rock oil in Pennsylvania, &c.

The cost of digging this coal at Cannelton, last winter, was 3½ cents per bushel. The tariff on the Chesapeake and Ohio Railroad is 1½ cents per ton per mile. The distance to the docks at Richmond is 340 miles. The cost of transportation thence to New York is from $2 to $2.50 per ton, by water. The selling price in that city is $14, $16, $18, and even up to $23 and $25 per ton.† From this some idea can be formed of the business that may be done in the eastern markets in this coal, not to mention the great and ever-growing West.

In this coal field, therefore, are found coals of various compositions, and adapted to all the requirements of trade and manufacture. The fat, caking, gassy bituminous, the hard and valuable splint, and the rich and oily cannel, are all here and made easily accessible to the miner through the

* New York *Times*, 1856. This is the latest information on this point I can find. The coal was never distilled on a large scale, that I am aware of; was always shipped direct.

† The price now (in April, 1873) is $25 per ton of 2,000 lbs.

agency of running water, which has exposed the strata in hundreds of places. "These coals, as they occur in the Valley of the Kanawha, are generally purer, better and more available than those of any other portion of the Alleghany coal field. The seams in it are more numerous and their thickness much greater, and they can be mined cheaper and with more economy, under the same rates of labor, than in any other part of this country, *without exception.*"*

The general thickness of the seams is remarkably shown by the following: On Elk, Gauley, New, Kanawha, and Big and Little Coal Rivers and their tributaries, I have visited 93 exposures of seams, and have 16 others reported to me by reliable authorities. The total thickness of these 109 exposes is 540 feet 7 inches, which gives 4 feet 11⅓ inches as the average thickness of each exposure. The average amount of slate, &c., in each is 4½ inches, which leaves an average of 4 feet 6⅝ inches of clear coal; a most striking amount when the observations extend over the greater part of the coal field. If all of the places I visited were fully opened up, the total thickness would be still higher.

The roofs of the seams are remarkably fine and good, it being the exception when they are not. Consequently the mines require but a small amount of timber, which is always close by and ready to the hand.

As an example: In July, 1872, I had occasion to go into the Old Dominion Mines, on the Kanawha, which have not been worked since 1858 or 1859. The entry at the back was not timbered at all, and yet, with the exception of a few flakes that had scaled off, I found the roof perfectly firm and solid. Moreover, the crush had been so slight that the pillars could be now mined and shipped, and this, notwithstanding that water, owing to a fall at the mouth of the entry damming it in, had been standing in the mine half way up the seam, and tending to decompose it, for

* Coal, Iron and Oil. Daddow & Bannan. Pottsville, Pa. 1866. P. 340.

many of these years. Of course, over so great an area as this field, kettlebottoms and slides in the roof will be met with, but good roofs are the rule, and to them may be added firm floors.

At present coal is mined here by hand labor altogether, and costs for digging 3½ cents per bushel.

Coal cutting machines can be substituted with great advantage. They are of two classes; one percussive, and imitates the cutting operation of the pick as swung by the miner; the other acts continuously by cutters which are pressed against the coal, and shave it off little by little. I note one of each class, and the better to appreciate them will first state what a man does.

An experienced miner makes about forty blows per minute and cuts from three to four feet under the coal, at the rate of one to one and a-half linear yards per hour. To allow the necessary space for his body under the coal, as he lies on his side, much of it must be cut away and destroyed. It is estimated that under such circumstances he exercised about one-sixth of a horse-power, which is applied percussively.* Compare this with

CARRET, MARSHALL & CO.'S COAL CUTTING MACHINE,

which is prominent amongst those of the second or shaving type.

It is claimed that it has the power of eighteen men; that it can work effectively in a two-foot seam, accomplishing more in one minute than seven hundred blows from a pick can in the same time. The motor is water, under a pressure of about 300 pounds, and supplied at the rate of 30 gallons per minute. The same water is used again and again. The cutting tools are 3 inches wide, and penetrate 4 feet, with a power of eighteen men. This is effected by a consumption of 50 pounds of coal per hour to feed the boiler, which, of course, is outside the mine, or at some place where the ven-

* R. W. Raymond, United States Commissioner of Mining Statistics.

tilation will not be affected. It requires the attendance of simply a man and a boy, and completes 15 yards per hour. If found advisable, the under cutting can be done in the floor, thus leaving the whole of the coal available. The cost of this machine, as here described, is £125 or $625. It is claimed that the saving in coal alone more than pays for the outlay; the amount of slack is considerably reduced, and a single seam, it is said, will yield more by 1,000 tons of coal per acre than when worked by hand labor in the usual manner. A machine of the first-class is that of

MESSRS. JONES & LEVICK,

which may be described as one for holding and swinging a miner's pick, so as to undercut as by hand. It is worked by compressed air, which escapes into the gallery, promoting ventilation. I subjoin the reported results of experiments made by this machine in two mines in England.

In the High Royd Colliery, in a hard coal, and in a gallery in which the roads were in a bad state, with an air pressure of 2 to 2½ atmospheres and 70 to 80 blows per minute; the average hour's work of the machine, including stoppages, was a channel from 25 to 30 feet long, and from 3 feet to 3 feet 3 inches deep. The width at the bottom was 1$\frac{44}{100}$ inches, and on the face 3$\frac{14}{100}$ inches. During ten hours consecutive work, the work produced by it was equal to that of twenty miners during the same time.

These machines do not break down the coal, but leave that for the miner; and here again, machinery worked by hydraulic pressure can be very advantageously brought into play. For details concerning this, I would refer to the London Mining Journal, June 12, 1869.

From these statements it will readily be seen that great saving over the present system (which pays well) can be effected with mining machinery.

I have hastily spoken of the seams which may be expected below water level. But when it is remembered what work-

able ones are above it; that an acre of coal 5 feet thick contains about 8,000 tons; that a nearly perfect system of mining and cheap labor has enabled England to work 11 inches of coal in the Forest of Dean; that Pennsylvania works successfully seams only 2 feet 8 inches thick; it will be seen that there is no need to sink shafts at all, and that it will be a long time before the cost of winning coals from dry levels will be so far raised as to actually necessitate other styles of working.

Indeed, when that mighty and devastating rush of waters occurred, which, by rapid drainage, scooped out enormous valleys and basins in the upper strata, it prepared this field with numerous objective points for safe and economical working, while it left the greater part of the coal measures above water level, accessible at many points by simply removing from their outcrops the alluvium that has formed there by the decaying work of ages; and there seems to be no other coal field where so small an expenditure of capital and physical force, will prepare so many mines to deliver coal at the mouth of the drifts as is the case in this.

This will more clearly appear by a comparison of the position of the coals here and in Great Britain in this respect. There the coal is deep below water level, and to reach it requires years of labor and vast sums of money. In its great northern coal field the shafts are rarely less than 150 feet deep, and many have the great depth of 1,800 feet sunk at an expense, in some cases, of $240,000,* while the Dukinfield Colliery was taken down 2,600 feet at a cost of $500,000, mainly to reach the "Black Mine Coal," a seam 4 feet 8½ inches thick.

"There is now simply invested in pits and machinery for pumping and hoisting the 100,000,000† tons of coal produced in Great Britain, $200,000,000. To this must be added the

*Sweet's Special Report on Coal to the New York Legislature. 1865. Page 11.

† In 1871 the product was 117,000,000.

necessary expenses of constructing and maintaining proper air courses and their accessories requisite to the safety of the employees, and this vast sum is destined to utter destruction in serving the purpose for which it is used."*

Here mighty natural forces have sunk pits which need neither repair or renewal. The inclination of the strata, coupled with the laws of gravity, have provided the most costless, perfect and permanent pumping machinery, and the perfect ventilation of the mines is but a matter of the most simple and ordinary care, as there are none of those noxious gases to be dealt with which ofttimes render coal mining so dangerous.†

Although this portion of the report extends to some length, it contains but little more than a mere outline of the whole subject, and can only afford a glimpse of the prospects fairly in view.

Bituminous Schist or Cannel Shale.

There are many seams of this, varying from 2 to 5 and more feet thick. In appearance it is like cannel coal, for which it is often mistaken, but from which it can be distinguished by its greater specific gravity and its slatey structure, this latter being particularly observable where the blocks have been exposed for any time to the weathering action of the atmosphere.

It burns well, evolving great heat, and ignites readily, but leaves so large an amount of ash as to render it unfit for fuel. It seems to be almost, if not quite, as rich in oils as cannel itself, and is therefore very interesting; for if oil can be made from it at the figures usually given, the undertaking could scarcely fail to be remunerative.

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*Mineral Resources of Virginia and West Virginia. 1871. Page 14. Hon. Howell Fisher, M. E.

† In every mine in the Valley open lights are altogether used.

There is at New Galilee, Pennsylvania, an establishment for the manufacture of oil from these shales in successful operation. In 1870 I was indebted to the kindness of R. P. Rothwell, M. E. of Wilkesbarre, Pa., for the following letter concerning it from the manager:

"The machinery used by myself, after some considerable alterations, finally works to my entire satisfaction. I am able to produce oil from my present means at 3½ cents per gallon, and that of the best quality. My works here cost some $53,000, but starting new again, I believe that the advantages I possess can be obtained for $30,000. * * * The shale which I use is very lean, only producing 50 gallons to the ton, yet I will be able to make the crude oil at a cost of 1½ cent per gallon when I am able to enlarge my works."

In 1865 these shales were worked in many localities in Scotland, and the works for distillation were extending, while in the single county of Staffordshire the product was 10,000 tons, selling at the pit's mouth for 12 shillings, sterling ($3).*

A seam of this material 4 feet thick will yield over 8,500 tons† per acre, which, at 50 gallons per ton, would give 425,000 gallons or 9,885 barrels. The average market price for 1871, in the Titusville oil region, was a fraction over $4.40 per barrel.‡ At this figure, a seam such as I have described would yield $44,494 worth of oil per acre.

Numerous places can be found advantageous for the location of these distilleries, with all the lumber necessary for cooperage, ready to the operator's hands.

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* Mineral Statistics of Great Britain. 1865. Page 221.

† Specific gravity taken at 1.6.

‡ Titusville Courier, 1872.

Salt.

The salt of the Kanawha Valley has long been favorably known, particularly in the South and West, as a most superior article, and has generally commanded a preference in whatever market it was introduced. Before the war the product was 3,000,000 bushels annually. Up to that period all pickled beef and pork purchased by the Government was required to be cured with it. Many of the furnaces were then destroyed or stopped, and hence another article is now used. It has the great advantage of being free from the bitter salts of lime and magnesia, and has to go through no special process of purification, being put directly from the evaporating troughs into the barrels.

The brine is obtained from borings varying from 1,000 to 2,000 feet deep, the majority of which are to be found at the Kanawha Salines on both sides of the river, from 3 to 8 miles above Charleston. At the Burning Spring Furnace so much gas is ejected with the water that no pump is necessary, and being burnt in the furnace, it necessitates only half the coal that would otherwise be used. At the Snow Hill Works, the most extensive in the Valley, the brine stands at 10° Baume.* Many of the furnaces have heretofore been "dead rented" by the Ohio companies. Those now in operation are: the Burning Spring, Snow Hill, Brookes, the Alden Chemical Company, and the Lorena.

The saliferous formation underlies the whole coal field, and from it come the brines to supply the furnaces in Mason County on the Ohio, while higher up the Kanawha, and in Braxton, Webster, Fayette, and Greenbrier counties, it has also been struck, but never evaporated on any scale. As to its strength in these latter places, I am not informed, though in the four last salt has been manufactured for local use, these localities being too remote from any line of transportation to ship it.

* 25° B. is saturation.

The following letter from Dr. J. P. Hale (who has been for many years interested in salt making, and is now the owner of the Snow Hill Furnace,) on the salt of Kanawha, and its dependent industries, is extremely interesting:

CHARLESTON, W. VA., 1st April, 1873.

To Prof. M. F. Maury, Jr.

DEAR SIR:—In reply to your inquiries as to the manufacture of salt, soda-ash, bromine and glass in the Kanawha Valley, I claim that it possesses advantages superior to any other locality in the United States. The consumption of salt in this country is approximately one bushel per annum to each inhabitant; aggregating, therefore, about 40,000,000 bushels per annum. About one half of this amount is made in the United States, chiefly at Syracuse, Saginaw, Pomeroy and Kanawha, besides half a dozen smaller producing localities in as many different States, and the remainder is imported chiefly from England, with all the additions of duty, freight, commissions, exchange, risks and profits. These disadvantages limit the foreign salt chiefly to the sea-board States, while we, from Kanawha, have easy access with cheap freights to the great interior markets of the Ohio and Mississippi Valleys.

There is no other place within the United States where salt water of equal quality and abundance, coal for fuel as good, cheap and abundant, and timber for packages as good, abundant and cheap, can be found together as in Kanawha. It follows, therefore, that salt can be made, barreled, shipped and delivered in the Western markets cheaper from this region than from any other source, and this is exactly what I claim to be true.

Another most important consideration is the superior quality of Kanawha salt. Most other, domestic and foreign, has a greater or less admixture of sulphate of lime, which renders it less penetrating, and more apt to dry, cake and crust on the surface of the meat under unfavorable circumstances of climate or weather, allowing the centre to spoil. Kanawha salt is entirely *free* from sulphate of lime; penetrates and cures meat to the bone in any weather and in any climate, besides having a more lively, pungent and pleasant taste as a table salt than any other known.

The packers of the West fully understand its superior antiseptic and curative qualities; and, after more than half a century's experience, prefer it to any other.

About $75,000 will erect a new furnace of a capacity of 500,000 bushels per annum. Salt can be made on such a furnace for about 10 cents per bushel in bulk, or 16 cents in barrels ready for shipment; it can be freighted to Cincinnati by tow-boats and barges for about 3 cents per bushel. The average price in that market for 10 years past has been not less than 38 cents per bushel. Allow 9 cents per bushel for commissions and contingencies (a large estimate) and it leaves a net profit of 10 cents, which gives $50,000 per year on one furnace.

Do you ask if there is a market for this salt? I answer, yes. At these prices there is a market in the great West against all competition, for all that we may make.

But there is a more important market on the premises where made, for all the salt that is likely to be manufactured. I mean in the manufacture of alkalies. There is not a *soda-ash furnace* in operation in the United States. England has the monopoly for the world. In 1869 there were consumed in the manufacture of alkalies in that country 10,184,000 bushels of salt; 961,000 tons of coal; 281,500 tons of limestone and chalk; 264,000 tons of pyrites; 8,300 tons of nitrate of soda; 33,000 tons of manganese, and 33,000 tons of timber for casks, making a grand total of 1,834,400 tons of raw material for alkali manufacture. The number of men employed was 10,000, and the value of the product $12,500,000. These figures will serve to show the immense extent and importance of this branch of industry.

Why is the manufacture not carried on in this country? The answer is: Simply because it has not been attempted at the right place. There have been two or three unsuccessful efforts at or near New York, where salt was worth 30 to 50 cents per bushel; coal $4 to $8 per ton, and other necessary materials at proportionate rates; and this, too, where the imported article is cheapest. It is easy to see why the undertaking could not succeed under such circumstances.

There are, indeed, not exceeding two or three localities in the United States, where there is such a combination or close proxim-

ity of the raw materials as would justify the effort to manufacture. Among these localities, Kanawha possesses advantages superior to any other for the same reasons as stated in regard to salt making. There is no reason, therefore, why the manufacture should not succeed here, but, on the contrary, there is every reason why it should, and that up to the full expectations of the most sanguine.

I send you a copy of a careful and accurate estimate, made by a competent and experienced chemist, (W. M. Habirshaw, of New York,) in March, 1870, giving the probable results of the manufacture in Kanawha. His estimates are based upon the investment of $100,000 in the business; $75,000 to $80,000 of which would be required for the erection and starting of works producing 10 tons per day, and the remaining $20,000 to $25,000 to be used as working capital. The price of the product he has put at the then importers' wholesale price in New York ($2.37½ per pound.) The price which would be gotten in the Western markets where our product would go, would, of course, be as much more than New York prices, as represents the freights, commissions, profits, &c., between the New York importers and the Western consumers. But even at the low prices stated by Mr. Habirshaw, you will see that his estimated profit is $422.35 per day, or over $150,000 per annum. Surely this ought to satisfy the demands of reasonable parties as a profit for such an investment.

I cannot give you as accurate figures and estimates about *bromine* as in regard to salt and soda-ash; but I think the following general statements are safe with a margin.

The bittern from a large salt furnace, such as I have described, will make about 100 pounds of bromine per day. The cost of bromine works of that capacity would be about $10,000; the cost of manufacture would be about 50 cents per pound; the price in market about $1 per pound: profit per annum, say $15,000. This may be a small matter as compared with iron, salt, soda-ash, &c., but to its extent a very important and promising enterprise.

The principal raw materials for the manufacture of *glass* are sand, salt, soda-ash and fuel. With all these things on the premises at cost prices, it is clear that this will be the best location in the country for glass works. This is the opinion of an experienced

glass-maker, (Mr. Duff, of Pittsburg,) who says, the white sandstone of this region will make excellent glass material. An ordinary sized glass works consumes $5,000 to $8,000 worth of soda-ash per month at Pittsburg prices. A few glass furnaces, therefore, would make a good market on the premises for soda-ash.

Very respectfully, yours truly,

J. P. HALE.

WATER POWER.

On New, Gauley, Elk, Kanawha and Coal Rivers, besides on many large and powerful creeks, can be found rapids and waterfalls of thousands of horse power.

At the Falls of the Kanawha the water has a descent of 18 feet. Here is a most advantageous location for mills, especially those for the manufacture of paper from the soft woods of the poplar and buckeye, both of which are found in great quantities up Gauley, down which the logs can be brought, especially now that that stream is being improved so as to allow them to come over the shoals at all seasons. Moreover, while New River is muddy for many months in the year, Gauley is almost always pure and clear, the two waters keeping distinct till after they pass over the Falls, which are two miles below the confluence of the rivers. This is most strikingly shown in the time of freshets, when the clear stream from the latter is seen on the western side, and the muddy of the former passing over on the eastern.

The Commissioner of Statistics for Minnesota remarks "that it is chiefly owing to two physical circumstances that New England has attained her present eminence in manufactures. The first of these is her abundant water power."

From another source we learn: "Ten thousand horse power at Lowell, Massachusetts, has collected a population of 40,000, and produces an annual value of $24,000,000; Fall River has a population of 23,000, and a valuation of $17,000,000. Lawrence, with a power equal to Lowell, has

already a population of 30,000. In general, a population of 1,000 may be looked for in each 166 horse power employed in textile or equivalent manufactures."

The value of water in driving machinery is, however, brought more clearly to mind when it is stated that it is paid for in other States at an annual rental of from $20 to $50 per horse power, according to location and demand.

Timber.

The extent and variety of this is perhaps as remarkably fine as are the deposits of coal. After spending some time in these forests, one does not appreciate the size of the trees, but upon leaving the coal strata and going east of the Alleghanies, they there look small in comparison.

Except along the river fronts, and on the bottom lands of the creeks, where small clearings have been made, by far the larger portion of this region is yet covered with original growth of excellent timber. Poplar, white, red, black and chestnut oaks, hickory, beech, black and white walnut, maple, chestnut, locust, wild cherry and the sugar maple abound. I have frequently noted groves of trees in which white oaks belted 10 and 11 feet, poplars 14 and 15 feet, and the other classes in the same proportion. In Webster County, on the headwaters of Gauley, the wild cherry grows 60 and 70 feet to the first limbs, and measures 3½ and 4 feet across the stump. To a foreigner to the State it would seem almost incredible, that on the headwaters of the Greenbrier common farm fences are built of black walnut, worth in Baltimore $80 to $90 per thousand feet, and that often these valuable timbers are burnt in the field to clear the land for tillage.

The West, to say nothing of the Eastern markets, will always afford a ready sale for all lumber that can be cut from these lands; and there is no reasonable doubt that

lumbering, managed with energy and care, will prove remunerative in the highest degree.

To the European immigrant, unaccustomed as he is to the use of the axe, this timber is an insurmountable difficulty, and he passes it by, preferring the level lands of the West, rather than undertake the unusual task of clearing the acres he needs for the support of himself and family. But with access to market, this state of affairs will soon undergo a rapid and radical change. The car builders, the cabinet and boat makers, wheelwrights, house carpenters, lumbermen, and the numerous other industries dependent upon cheap lumber, will come into this region to supply their wants.

The large supply of good bark will bring tanneries and their associate employments, and when to these sources of demand and markets for supplies is added the timber that will be carried out and sold in bulk, it will at once be seen how acre after acre will soon be opened to the husbandman, not only without cost, but with a handsome profit for what it has yielded, and independently of the fact that the lands thus cleared remuneratively, will be worth then, for the purposes of farming, many times as much as they were before they were reclaimed.

Iron.

The iron to be found within the Virginias may be divided into two classes:

1st. Those ores which belong to, and are found in the Appalachian coal measures, and,

2d. Those which belong to the great iron formation lying between the Alleghany Mountains and the Blue Ridge.

The first class is by no means so rich or so abundant as the second. It consists of the brown oxides and carbonates of iron. In the northern portion of West Virginia they have

been developed to a certain extent, but in the lower half little notice has been taken of them, and very little investigation has been made. I have seen beds of poor and inferior Black Band ores, and there is no reason that better should not be discovered upon careful search. Should they be in workable quantities, the value of the coal present will be much enhanced.

The brown oxides of iron are sometimes found here in strata of poor quality, but they are usually in pockets. They are the result of the decomposition of the carbonates of iron that existed in the beds that were once superimposed upon the present strata. These beds have long since been worn off by denudation. As the softer materials were washed away, the carbonate of iron settled down and was left resting on our hill-sides. In some places a great deal was deposited together; in other places but a single lump, and hence it is that on many of the mountains are found pieces of good ore, and yet no deposit near. This carbonate of iron, by atmospheric agencies, was converted into the brown oxide in which the earthy impurities of the former were concentrated, and consequently, as a rule, these ores are not very rich. Some of the deposits may do to work in conjunction with the richer ores from elsewhere, as we see done in Pennsylvania, &c., but I know of not a single instance in the Valley which, by itself, would justify the erection of a furnace.

Bands of clay iron stone have also been found, but so little is known of their extent or quantity, that the mere mention of them will at present suffice.

The second class of ores mentioned, are a part of that great iron belt of the United States which, beginning in New York, runs through Pennsylvania, furnishing many of the largest furnaces of that State with their stock; crosses Maryland; passes through the entire width of Virginia; constitutes the iron region of East Tennessee, Western North

Carolina and Northwestern Georgia, and ends in the unparalleled and magnificent deposits of Alabama.

In this belt the ores, for the most part, are the brown oxides, yielding in Virginia from 40 to 50 per cent. of iron. They are usually worked in open quarries, and though fine in the northern portion of the State, increase, both in quality and quantity, as we follow the belt in its southwesterly course, till in the last counties to the south they are very rich.

In treating of the geology of this portion of the State, Professor Rogers says: "Of the twelve rocks, each marked by certain distinctive characteristics, composing the mountains and valleys of this region, it has been determined that at least eight are accompanied by beds of iron ore."*

General Haupt,† in speaking of the minerals along the line of his road, which runs in this iron belt across the whole State, says: "The iron deposits are very numerous and of superior quality. Pennsylvania, rich as she is, is poor in iron ores as compared with Virginia."

Scattered throughout this belt are many charcoal furnaces, some of them producing metal of such quality that, in 1871, it was bringing $55 to $56 per ton in Philadelphia, while the Pennsylvania iron on the Lehigh was selling for $35. On the eastern edge of this iron country, on both sides of the Blue Ridge, are the magnetic and red haematite ores. In the northern part of the State I know at present but little of them, but beginning about the line of the Chesapeake and Ohio Railroad they are good, increasing as we go southwest. On the James River, in the counties of Bedford, Amherst, Nelson, Buckingham, &c., the magnetics are exceedingly fine, and would be brought into communication with the West Virginia coals, either by means of the James River and Kanawha Canal, or by what is known as the

* Geology of Virginia. 1836. W. B. Rogers, State Geologist.

† Chief Engineer of the Shenandoah Valley Railroad.

"straight shoot" of the Chesapeake and Ohio Railroad, from Clifton Forge down the James, on the short cut to Richmond.

In Patrick, Henry, Floyd, Carroll and Grayson counties, both classes abound, and, together with the rich brown oxides from Wythe, Smyth, Washington, Giles, Tazewell, &c., would best come to West Virginia fuels, by a railroad constructed up New River from the Chesapeake and Ohio Railroad from the mouth of the Greenbrier.

Thus there are in Virginia all the classes of iron ores required to make metal of good quality.

Communication with Market.

To get these resources to market, and to render all of the iron region tributary to the coal, the country has to be reticulated by highways of transportation.

The only one now completed is the Chesapeake and Ohio Railroad, which runs across the Kanawha coal field and bisects the iron belt of Virginia, giving to this region a shorter, quicker and cheaper route to both Eastern and Western markets than is, or can be, enjoyed by any other similar mining and manufacturing centre on the continent.

The James River and Kanawha Canal—the commercial supplement of the Chesapeake and Ohio Railroad—is to come down New River into the Kanawha. It has been completed from Richmond to Buchanan—197 miles—leaving a gap of 103 miles to the mouth of Gauley, and 100 miles more to the mouth of the Kanawha.

"When it is done, with a capacity as great as the drainage and feeders of the country will sustain, it will make tributary to Virginia waters the whole of the hydrographic basin of the Missouri as far as the Rocky Mountains, and of the Upper Mississippi as far as the Falls of St. Anthony. This line will open up water communication from Fort Benton, 3,100 miles above the mouth of the Missouri, all the way to the Chesapeake Bay.*

*Physical Survey of Virginia. 1869. Page 20. Com. M. F. Maury, LL. D., &c., &c.

As regards its chances for completion, the following letter from Commodore Maury, who will be readily admitted as an authority of the highest standing, is very interesting:

VIRGINIA MILITARY INSTITUTE,
LEXINGTON, 6th July, 1872.

Col. R. L. Maury.

MY DEAR SIR:—You ask my opinion as to "the probabilities of completing the James River and Kanawha Canal." I think them not only reasonable but proximate, and any one who will make himself acquainted with that work, who will consider the rapidly increasing population and production, the growing wealth and political power of the West, and who will then consider what has been done with regard to it, will be very apt to come to a like conclusion.

That work was commenced more than a generation ago by the State of Virginia. After reaching the eastern base of the Alleghany Mountains, the work, owing to difficulties of various sorts, and the absence of appropriations and the exigencies of war amongst them, was suspended.

During this long suspension, the public mind was withdrawn from this great canal and given to things of more absorbing interest. But that attention was recalled to it by "*Report No.* 1, *Physical Survey of Virginia.*" * * * * *

Look at the map and you will see that Virginia is as the keystone to the arch of States that border on the Atlantic Ocean. She has the best harbor of the coast, is midway between the Northern and Southern extremes, and offers the shortest and best passage that can be found for commerce between the Atlantic seaboard and the chief centres of the Mississippi Valley, such as Cincinnati, Louisville, St. Louis, St. Paul, and even to Chicago, on the lakes; for, if you will take the trouble to measure, you will see that by opening these routes, they will bring the capes of Virginia and the sea, nearer to Chicago than Sandy Hook now is.

The Government in Washington, impressed with these facts, have sent out their corps of engineers to examine the ground and see if a practicable route for the canal can be found, and they have found it, for it was well known to exist. And in anticipation of this canal at an early day, Congress and the city of Rich-

mond, as if to prepare for it, have moved in the matter and are now spending large sums of money upon the improvement of James River. They aim ultimately to give this river 18 feet* of water from the city to the sea, and by so doing to bring the seaport of the great West 100 miles up into the interior; and then by opening docks for its shipping, they expect to establish that port at Richmond. * * * * * *

For my part, content to wait and watch, I look upon a canal from the James River at Richmond to the "fairway" of the Kanawha River, as a thing that *must* be. There is no event of the future that falls not in the "order of nature," but which depends upon the accidents of time and circumstance, the coming of which I regard as more certain than the completion, sooner or later, of this canal. It is a work of transcendent importance and must be built. Yours truly,

M. F. MAURY.

This matter was urged most strongly on the Congress of the winter of 1872–3. It was referred to the proper committee, who reported most favorably upon it; but an appropriation was not then granted, by reason of the lack of necessary information in the subject.

MARKETS AND MEANS OF DEVELOPMENT.

First, there is the Eastern one of the Atlantic States, which the Chesapeake and Ohio Railroad has opened; and next is the Western region of the great Mississippi Valley, with its 20,000 miles of navigable waters, and its system of 20,000 miles of railroads now in successful operation, and its hundreds of thousands of coal-burning engines, locomotives, factories, furnaces, machine shops, &c.

These rivers and railroads traverse the country of sixteen magnificent, populous and growing States (containing an aggregate of 1,000,000 square miles), unite more than two hundred towns and cities, of which at least 25 per cent. con-

*At present it has 12 feet.

tain each a population of 20,000 and upwards, and minister to the wants of 10,000,000 of people.

The better to form an idea of the wealth and demands of this Western country, I would state, on the authority of a pamphlet issued by Messrs. Fisk & Hatch, bankers of New York, in January, 1872, that the "tonnage of the Upper Ohio, in steamers, barges and boats, exceeds that of New York; and that the trade of the Ohio River, as estimated by Government engineers, exceeds the entire foreign commerce of the United States."

Last year there floated past the mouth of the Kanawha upwards of 60,000,000 bushels of coal to help supply this region. The West Virginia coal field is the most reliable eastern limit of this Mississippi Valley, for the Northern Ohio, Pan Handle and Pittsburg regions are, by reason of ice and low water in the Ohio above the mouth of the Kanawha, blocked out from it for many months in the year, when the Kanawha coals could pass on down.

Before the war, the consumption of mineral fuel was increasing year by year at a rapid rate throughout the West, and as the growth of that region in population and wealth has been even more rapid since that time, so the demand for coal has increased, and must do so, to enormous bounds.

Again, not only does the market become greater by increase of population, but it makes larger demands, year by year, from additions and improvements to the arts and manufactures; for every new invention of a labor-saving machine usually implies a new source for the use of coal, either directly, in the production of steam to run it, or indirectly, in producing heat or steam for its manufacture, and often for both. To prove this statement, which will scarcely be contradicted, I take Great Britain as an example, as her population has been pretty much at a stand-still for the last decade. I deal merely with the round figures, the details of which may be found in the Mineral Statistics of Great Britain for 1865 and 1872. In 1862 that nation raised 86,000,000

tons of coal; in 1871, 117,000,000 tons—an increase in ten years of 31,000,000 tons, or 38½ per cent.

Now take the United States, with *its* improvements in the arts and manufactures, *plus* its increase of population, for the last *nine* years. In 1864 it consumed 22,500,000 tons; in 1872, 41,500,000—an increase of nearly 84½ per cent.* But though the growth of the United States coal production has been great, we can look forward to a still greater increase in that trade, and therefore another stimulant to the development of West Virginia coal.

Last autumn the most prominent topic of discussion in England was the tremendous rise in the price of coal, which had gone up 100 per cent. in twelve months, and was still rising. This, of course, to say nothing of the direct effect on the supply of fuel, must raise the price of nearly all commodities, through its effect on iron, the great instrument of production and transportation. The *Economist* ascribes the rise to the tremendous growth of every branch of industry, both at home and abroad, for the last five years. Railroads, steamboats and factories have all multiplied beyond example, and are all working to their utmost capacity; and the strain on the mines has at last become almost as great as they can bear; so the price has run up. The results will probably be, as regards manufactures, a great diminution of profits for some time, as producers cannot well raise their prices to the full extent the rise calls for.

Hitherto England, by reason of her cheap manufactures, has been supplying the world with the products that her coal has wrought into marketable shapes, and even to the United States has been sending iron and manufactured goods innumerable.

But now that her coal has risen and the price of production increased, some of the factories for the world that have hitherto been located there, must be established elsewhere, and to the States many of them must come.

* Compiled from the Miners' Journal Coal Statistical Register for 1873.

We begin to see the effect of this rise on the American market already, in the facts that the French line of steamers from the United States, which formerly used English fuel, has now changed to American coals when filling their coal holes on this side of the Atlantic; while Cumberland is shipping fuel to the coaling stations on the west coast of South America, where aforetime the English was used.

But though all these demands are great, one of the largest, if not *the* largest for the West Virginia coals, especially for the splint, has yet to be mentioned. I allude to the consumption that will, in a few years, be found within our own borders in the blast furnace.

In the history of that trade, the iron ore has usually come to the coal and not the coal to the iron ore; though in this case, owing to the nearness of the one to the other, a reciprocity of freights will be established, and each will be taken into the others district.

Nearly all the iron made in the iron belt of Virginia, before spoken of, is reduced by charcoal. But timber is too soon stripped from the vicinity of a furnace to depend upon it as a smelting agent in very large and extensive works; while in rolling mills, &c., coal is a necessity.

These Virginia ores must, therefore, look to other sources for their reduction, and most naturally they turn to the West Virginia coals; as they are the nearest, as well as the best.

On this point Mr. Mendenhall, in the conclusion of his letter to Mr. Paxton, the beginning of which I have before quoted, says: "Intelligent iron men have clearly seen since the trial of the character of your coals, that if they, the iron ores of Virginia and the Greenbrier limestone, are brought together, the Kanawha Valley and the ore region will, at an early day, be teeming hives of industry and wealth, and one of the most important centres of the iron manufacture must be in this portion of the State of Virginia."

At present the demand for iron exceeds the supply. That

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metal in England, in twelve months, has risen over 100 per cent., and in this country reaches the figures of $55 and $56 per ton. These high prices will consequently be a powerful stimulant to the iron manufacture of America, and call for the investment of capital in new fields. One of the most inviting of these are the regions which I have under discussion.

That the demand for iron in the United States has really overtaken the supply, is most ably shown in the report of Mr. Thomas Dunlop, Secretary of the American Pig Iron Association, made at a meeting of that body in New York city on the 19th of February, 1873:

"The increase in number of the blast-furnaces for 1872, far surpasses that of any year of which we have record. The total number of new furnaces built or begun in 1872 was 109, and of those projected for 1873, which only includes those actually determined upon, was 39. Giving this number an average daily product of 15 tons, and of 200 days in blast, we would have an addition to the product of 1870 of 327,000 tons. Fears have been expressed that this great number of new furnaces built would, in connection with existing capacity, overstock the market. We have only to note, in reply to this, that there have been 50 new rolling-mills built or begun, and that fully 30 per cent. has been added to the former puddling capacity of existing mills. When we review the figures of consumption, it will be clearly evident that the pig metal production is yet far behind demand." * * *

Consumption.

"The figures of the consumption of iron in our country are startling, although still only approximate, since it is impossible to obtain the requirements of all branches of trade. The following will give a good idea of what amount of iron we use:

	Tons.
Production of pig iron for 1872	2,400,000
Importation, all kinds, fiscal year	1,254,618
Total	3,654,618
Add American scrap used	400,000
Total consumption raw iron	4,054,618

"Where this is used may be imagined from the following statistics, which, so far as they go, are trustworthy:

Number of miles of Railroad in the United States	70,000
Tons of iron required to equip this, at 150 tons per mile	12,250,000
Required per annum for repairs, 10 per cent	1,225,000
Increase for last 3 years, 14.2 per cent	1,428,500
Annual increase, 7,000 miles per annum	1,050,000

"Total requirements of the railroads per annum, 2,478,-500 tons, or more than the total product of pig iron in the Union. This railway consumption is divided per mile as follows:

	Tons.
For rails, including track supplies	100
For locomotives	25
For cars	20
For sundries	5
Total	150

"A few of the other sources of consumption are very correctly approximated as follows:

	Tons.
Gas and water pipe	190,000
Ship building	40,000
Stoves	250,000
Mowers and reapers	33,000
Other agricultural implements	150,000
Miscellaneous castings	600,000
Sewing machines	20,000
Nuts and bolts	250,000
Nails and tacks	250,000
Architectural iron	150,000
	1,833,000
Railroad, as above	2,478,500
Total	4,311,500

"These figures show clearly that, without counting for any increase of business, the total possible product of pig metal for 1873 or 1874 cannot supply the demand for actual requirements.

"The immense amount consumed yearly in architectural iron is rarely considered, and yet during 1872, 48,000 tons were consumed for this purpose in New York city, Brooklyn, Jersey City and Newark. What have been the uses of this material for Chicago in the same time? Or what will be the demand for Boston in 1873? New and curious lines of consumption are constantly cropping up. Thus, the projected Gilbert Elevated Railroad for New York will require 5,500 tons of iron for five miles of road. Can we hesitate, under the teachings of the foregoing figures, to accept the fact that consumption has overtaken the supply, or that the demands of the future must far surpass those of the past and the present?"

Throwing out of my calculations that there is reason to suppose that iron suitable to mix with other ore will be found in the coal field, and assuming that only those of the iron belt of Virginia are used, I will point out the profit to be derived from the manufacture of iron in this State, so that it may be judged therefrom, what will be the probable consumption of coal for this purpose.

The cost of manufacturing a ton of pig metal is about $28.50 at Cincinnati; at Jackson, near the Ohio, $25; at Allentown, Pennsylvania, $29; in Beaver Valley, Pennsylvania, $27; in Massachusetts, $30. These figures are for 1871. Since then the prices of iron ores have risen, and consequently these costs are higher. Compare with them the estimated cost of making iron in the Kanawha Valley.

Two and one-quarter tons of ore on the cars @$1.25	$2 82
" " " " transported 150 miles @1¼ cent.	4 21
Three-quarters of a ton of limestone on cars (say)	75
" " " transported 80 miles @1¼ cent.	75
Two and a-half to two and three-quarter tons of coal @$1.50	$3.75 to 4.12
Cost of materials at furnace	$12.28 to $12.65

In this I have assumed that the ore is bought some 30 miles east of the western edge of the iron belt, that the furnace is in the centre of the coal field, and that it mines its own coal. The cost of the coal is the present price for production, but with proper mining machinery, &c., this can be much lessened. I prefer to leave the cost of making blank, for each iron master to make his own estimate; but even putting it at $6, up to which it will not and should not come, it would give as the total cost of a ton of iron $18.28 to $18.65 *versus* the prices I have given above.

Continuing this comparison into the farther manufacture of iron in its many branches, it will appear that the advantages offered by this Valley for such enterprises as foundries, rolling mills, &c., &c., are quite as great as those already set forth; for as finished iron and steel wares of all kinds require more coal per ton, in proportion as the amount of work on them is increased, such articles can of course all be turned out proportionately cheaper where fuel is cheaper.

I have now shown, and I believe distinctly, the natural resources of this section of the Virginias, and that the inducements for the investment of capital are:

1st. A very large area of nearly horizontal coal-bearing deposits of unusual regularity, great thickness and excellent quality.

2d. There are in this coal field numerous seams of splint, cannel and bituminous coal which rank with, and sometimes excel, the best coals of the United States.

3d. It has railroad connection with the Eastern markets, as well as communication with 40,000 miles of Western river navigation and railroads, along which are many large and manufacturing towns.

4th. Coal can be shipped to the West for many months in the year, when that from Pennsylvania and Northern Ohio, which now supplies by far the largest part of this market, is kept back by the difficulties of navigation on the Ohio above the mouth of the Kanawha.

5th. Much of its area is covered by virgin forests, containing nearly all the principal American trees.

6th. It has the advantage over Pittsburg, the chief coal-shipping port of Pennsylvania, of being nearer Cincinnati, and the other Western cities, by about 240 miles.

7th. The deposits of iron ores are of fine quality, in great profusion, and of all the varieties necessary for the manufacture of first-rate iron.

8th. The iron belt and coal field are within less than 100 miles of each other.

To conclude with the words of Professor Ansted: "More than this should not be needed to secure the employment of capital in this direction, and it would be difficult to set a limit to the amount that could be invested with advantage."

From a longer and more extensive acquaintance with these districts, I can, though unnecessary, most fully endorse what he says, and have no hesitancy in commending these regions to the careful notice of those who desire an advantageous location for mining coal, and for the erection of blast furnaces, &c.

M. F. MAURY, Jr.

Fellow of the Geological Society, London; Associate of the Royal School of Mines, England; Graduate of the Royal College of Chemistry, London; Mining and Civil Engineer, &c., &c.

Charleston, West Virginia, *May*, 1873.

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